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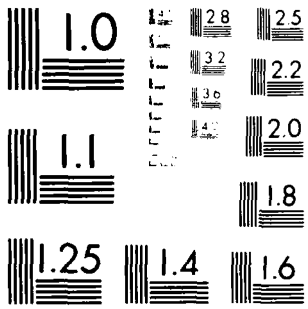

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IDA REPORT R-272

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AD-A142 569

IDA/OSD RELIABILITY AND MAINTAINABILITY STUDY

Volume I: Executive Summary

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Richard A. Gunkel
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November 1983

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Prepared for
Office of the Under Secretary of Defense for Research and Engineering
and
Office of the Assistant Secretary of Defense
(Manpower, Reserve Affairs and Logistics)

IDA

INSTITUTE FOR DEFENSE ANALYSES

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is in four volumes: Vol. I, Executive Summary; Vol. II, Core Group Report; Vol. III, Case Studies Analysis and Vol. IV, Technology Steering Group Report. Study Results were derived from case studies performed on eight existing weapon systems and from working groups that examined sixteen individual technology areas. Specific R&M recommendations are made in the following eight areas: Technology Base R&M Programs; R&M Demonstration Programs; FSED Planning and Analysis; R&M Standards; FSED Management Awareness of R&M; (contd)

20. (contd) New System Maturation; Collection and Use of R&M Data; and R&M Training.

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We would be remiss if we did not give special thanks to the hundreds of companies across the country and to all the Military Services for their support and numerous contributions to the study.

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John R. Rivoire
Director

CONTENTS

ABBREVIATIONS

BIT	Built-in-Test
CAD	Computer-Aided Design
CAM	Computer-Aided Manufacture
DARCOM	U.S. Army Materiel Development and Readiness Command
DoD	Department of Defense
DSARC	Defense Systems Acquisition Review Council
DSB	Defense Science Board
FIT	Fault-Isolation Test
FSED	Full-Scale Engineering Development
IDA	Institute for Defense Analyses
OSD	Office of the Secretary of Defense
R&D	Research and Development
R&M	Realiability and Maintainability
SSARC	Service Systems Acquisition Review Council
VHSIC	Very-High-Speed Integrated Circuit

I. SYNOPSIS

A. BACKGROUND

In recent years there has been a rising concern about DoD's ability to keep weapon systems both modern and combat-ready. At any given time the availability of many of these systems has been below that needed to maintain the required force posture. The seriousness of this problem was highlighted in the report of the 1981 Defense Science Board (DSB) study of the Operational Readiness of High Performance Systems. One of the major recommendations of that study was to design reliability into the systems from the start and mature that capability prior to full-rate production. The 1981 DSB study also highlighted problems with diagnostics and recognized that increasing system complexity, while not incompatible with readiness, made it imperative that the Department of Defense (DoD) demand and manage acquisition to achieve readiness requirements.

Because of the well publicized problems in reliability, readiness and support, DoD put improvements in this area high on its priority list. The Carlucci initiatives directed at reforming the acquisition process gave reliability and support considerations a very high priority. As a result there has been a major increase in DSARC and top management attention. On each major program there is visibility at the top on progress in meeting R&M objectives through development, production and in early field experience.

The track record from these efforts is uneven. Many of the more mature technologies have done relatively well in meeting reliability objectives. Newer, fast developing technologies

often have serious problems, however, as do programs with accelerated or compressed schedules. The latter are becoming more frequent due to the Administration objectives of fielding new hardware faster. Thus, there is a major challenge in learning to manage acquisitions on accelerated programs so as to attain desirable R&M objectives. Technology advances are potentially helpful in such areas (e.g., in electronics) by providing opportunities to improve both performance and R&M, provided the problem is attacked in both the technology base and the acquisition process.

In the future, increasing weapon system complexity and rising maintenance costs will lead to demands for higher levels of R&M. A review of the Services' Year 2000 studies identified a common theme calling for more flexibility, more autonomy, more dispersal, and reduced support tail dependency in combat forces. While the validity of the presumptions on which these requirements are based may be challenged, their general thrust is unmistakable.

As a result of these concerns, the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) and the Office of the Under Secretary of Defense for Research and Engineering initiated this study, "Steps Toward Improving the Materiel Readiness Posture of the DoD" (short title: R&M Study) at the Institute for Defense Analyses (IDA) with the purpose of identifying and providing support for high-payoff actions which the DoD can take to improve system design, development and support processes so as to provide quantum improvements in R&M and readiness through innovative uses of advancing technology and program structure (Appendix A, Task Order).

B. OBJECTIVE AND APPROACH

The objective of this study was to analyze the state of current and emerging R&M from two different standpoints: first,

by looking at specific new technologies for their potential contribution to R&M improvement and for the type of problems anticipated in their application; and second, by examining specific weapons system acquisition programs to assess the impact of their program structures on the achievement of desired R&M goals. After consultation with the Services and industry groups, and examination of pertinent reference documentation, sixteen technology areas were selected for study as follows:

- Artificial Intelligence
- Cabling and Connectors
- Computer-Aided Design/Computer-Aided Manufacture (CAD/CAM)
- Structural Composites
- Directed Energy
- Fiber Optics
- Integrated Systems of Manufacture
- Manpower, Personnel and Training
- Mechanical Systems Condition Monitoring
- Nondestructive Evaluation
- Operational Software
- Electronic Packaging and Interconnection
- Power Supplies
- Testing Technology
- Very-High-Speed Integrated Circuits (VHSIC)
- Diagnostics

Eight relatively successful programs were selected for detailed study to address the issue of program structure. The eight programs selected were as follows:

- APG-63 Radar (F-15)
- APG-65 Radar (F/A-18)
- APG-66 Radar (F-16)
- T700 Engine (BLACKHAWK)
- ASN-128 Lightweight Doppler Navigation Radar (LDNS)
- TPQ-36 Radar (FIREFINDER)
- TPQ-37 Radar (FIREFINDER)
- SPY-1-A Radar (AEGIS)

In addition, many other programs and associated reports were reviewed for specific relevant information.

Working groups composed of Service and industry personnel were then formed for each of the technology areas and programs to be studied. Working group activities were coordinated and overseen by an Executive Council Core Group made up of representatives from DoD and industry. All the Services, the Office of the Secretary of Defense (OSD), universities, and over 100 contractors participated in and contributed to the study (see Volume II, Appendix B, for membership in the Core Group and the numerous working groups). More than 300 separate meetings were held, encompassing technology and case study working groups, as well as conferences with senior military officers, government and industry executives. The findings and conclusions reported represent a synthesis of the quantitative and qualitative analyses these groups performed and the judgments they applied to the results.

C. REPORT ORGANIZATION

The results of the study are documented in the hierarchy of reports shown in Fig. 1. This volume, the Executive Summary, is a condensed summary of the conclusions reached in the overall study which are presented as findings and recommendations in Section II. The conclusions from which these are drawn may be found in Sections III and IV of Vol. II, Core Group Report.

Volume III, Case Study Analysis, is a summary of a series of case studies which were generated as a product of the main study. The case studies themselves are available as Record Documents to readers who wish to pursue specific subjects in grearter detail. Similarly, Vol. IV is a summary of a series of Technology Working Group reports which are also available as Record Documents.

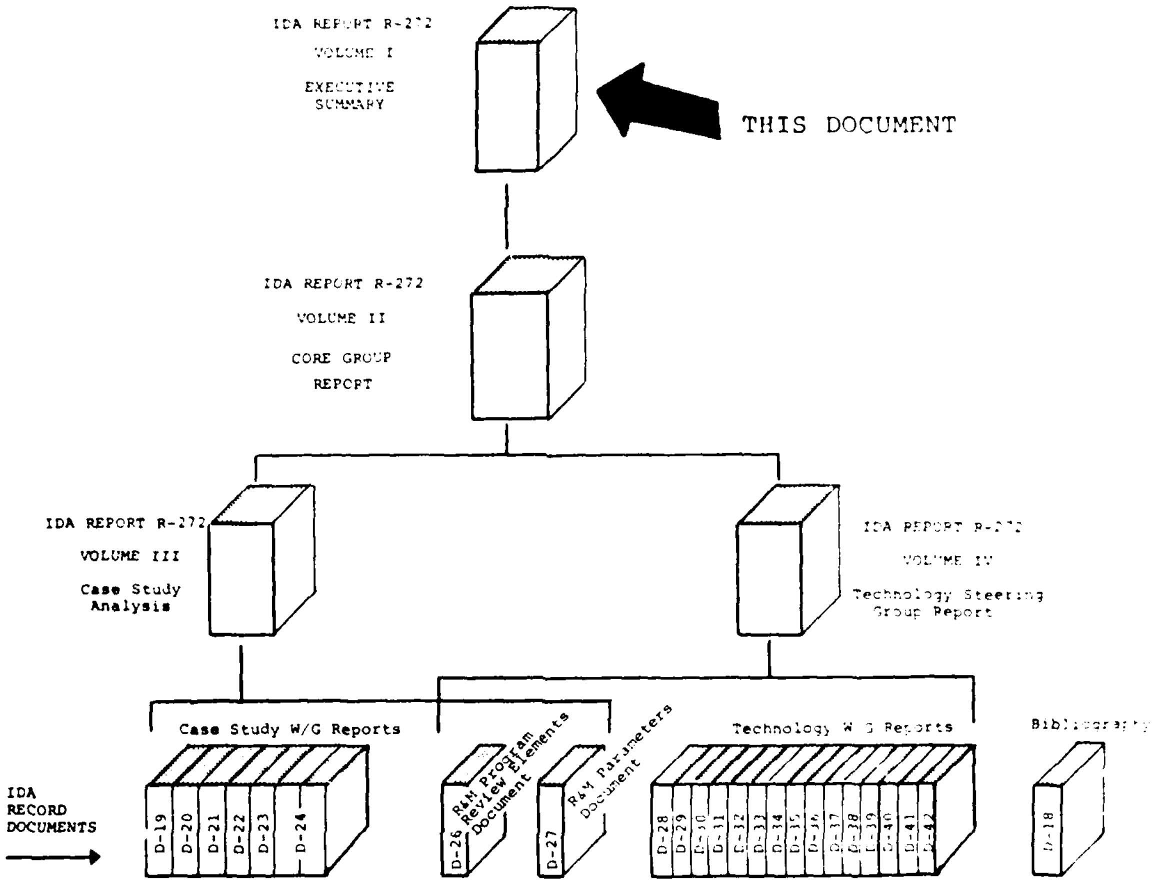

FIGURE 1. R&M Study Report Structure

D. RESULTS

Ten specific R&M recommendations in the following three categories are presented in the next section of this report:

A. Technology Base Structuring

1. Technology Base R&M Programs
2. R&M Demonstration Programs

B. Program Planning and Analysis

3. Program Planning and Analysis to Integrate Interdependent Elements
4. Recent Developments in Program Structuring
5. R&M Standards
6. Management Incentives
7. New System Maturation

C. Areas of Special Concern

8. Collection and Use of Field R&M Data
9. R&M Training for Managers
10. Diagnostics.

These recommendations offer fresh opportunities for the application of technology and management initiatives in new areas as well as in areas already well established. As a result of the large-scale participation by both industry and the Services, various actions have already been initiated to use information developed during the course of the work described above. Within the Navy and the Air Force, actions thus far are primarily program-level applications. The Army, however, has initiated, through the Materiel Development and Readiness Command (DARCOM) Headquarters, an action plan that defines tasks to be performed and assigns organizational responsibility for implementing some of the findings of this study (Volume II, Appendix C).

In addition it should be noted that, independent of this study, the Office of the Secretary of Defense (OSD) has established a Logistics Research and Development (R&D) Policy Council charged with giving increased emphasis to R&D in support of logistics needs. The policy decisions of this group are being implemented by a Logistics R&D Working Group consisting of OSD and Service representatives from both the logistics and the R&D communities. Some of the recommendations of this study relate to these new groups.

II. OVERALL FINDINGS AND RECOMMENDATIONS

A. *STRUCTURE*

These findings and recommendations integrate results of analysis across the disparate fifteen technology reports, seven case studies, and specific information from many other programs and associated reports, as summarized in Vol. II and detailed in Vols. III and IV. For convenience, these findings and recommendations are grouped into the three categories of Technology Base Structuring, Program Planning and Analysis, and Areas of Special Concern.

B. TECHNOLOGY BASE* STRUCTURING

FINDING 1: TECHNOLOGY BASE R&M PROGRAMS

Selective expansion of technology base programs directed to improve reliability and maintainability of components, subsystems and systems is needed for current and future military systems.

Comments:

Areas have been identified where additional technology efforts and/or coordination of existing efforts could improve the design data base and associated design alternative selections available to improve the reliability, maintainability, and/or

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*The "technology base" consists of R&D programs that are not associated with a system that is in or past full-scale engineering development. In general, these are funded in the 6.1, 6.2 and 6.3A areas, but exceptions occur.

readiness of current or future systems. Identified areas are: Composites, Corrosion, Predictive Techniques, Diagnostics, and Architecture for Reliability (Vol. II, Section III; Vol. IV, Section V). The combination of the expanding use of complex electronic and mechanical devices with embedded computer systems places greater importance on the accuracy and fault-free operation required from diagnostics systems such as built-in test and fault-isolation test (BIT/FIT). This expanding need, coupled with the poor performance of current diagnostics systems, suggests that an immediate and intensive effort is required to resolve this problem (Vol. II, Section III-D; Vol. III, Section IV).

Recommendation:

The Logistics R&D Working Group under the direction of the Policy Council is assembling individual Service plans and an integrated DoD plan for "Log R&D." It is recommended that the Technology Working Group Reports (listed on page I-3) be reviewed by appropriate Service agencies and laboratories as an input to the formulation of Service plans.

FINDING 2: R&M DEMONSTRATION PROGRAMS

There is a need to establish a set of R&M objectives supported by applied technology demonstration programs as an integral part of achieving advanced performance objectives. Such demonstration program plans should include "road maps" which relate the timing of technology developments to their use in the demonstration program. Management must also establish review procedures to ensure timely transition of support technology into weapon systems and support systems.

Comments:

There are insufficient demonstration programs in the technology base aimed directly at R&M objectives or which include

R&M advances along with performance advances. Most such programs are directed primarily at demonstrating improved performance capabilities of components or subsystems even though the potential for significant R&M advances is known and advertized (as in the case of VHSIC). In addition, technical analysis to determine underlying causes of failures is sorely needed to guide technology base development. Technical analyses should be conducted by appropriate laboratories and technology developments identified, "road maps" (for funding and scheduling) developed and prioritized, and target systems for demonstrations identified. This will provide for a more rapid adaptation/infusion of new technology whereby the technology can be matured off-line and proven acceptable for engineering use separately from specific engineering development programs (Vol. II, Section III-A, B, and C; Vol. IV, Section V).

Recommendation:

The Services should establish, with concurrence of the Logistics R&D Policy Council, a set of quantitative, user-approved R&M Objectives, which in turn can be used to structure quantitative design objectives for advanced technology subsystems and components. The Services should then prepare, and include in their plans given to the Logistics R&D Working Group, a coordinated program of demonstrations, based on technology availability, to reach these objectives. A set of time-based "road maps" to connect technology availability to end-use demonstrations should be constructed.

DoD and Service acquisition responsibilities and procedures should be established to ensure that a structured review of support technology is made at the time of acquisition strategy formulation for each new system in order to determine what support technology is ready for transition.

C. PROGRAM PLANNING AND ANALYSIS

FINDING 3: PROGRAM PLANNING AND ANALYSIS TO INTEGRATE INTERDEPENDENT ELEMENTS

Formalized program planning and analysis procedures are needed early in the acquisition process in order to reduce R&M/readiness risk and to ensure balanced considerations of performance, supportability, budget, and schedule.

Comments:

Year after year studies are performed to ascertain why programs fail or succeed in providing reliable and maintainable systems. However, surprisingly little is known quantitatively about the interdependencies of program activities which affect R&M results. In particular, management-level decisions on funding and schedule adjustments to programs as a whole appear to be made without awareness of R&M consequences. For example, the relationships between front-end funding profiles and the ability to carry out requisite R&M design, analysis, component development, and R&M growth tests are not often addressed in the critical early planning phases. To develop such a discipline approaches to program structure analysis must be pursued with vigor.

The need to emphasize R&M requirements starting with milestone zero and proceeding into the Full-Scale Engineering Development/Production process is spelled out in DoD directives (e.g., 5000.40 and 5000.39), and R&M Program Plans and their various elements are defined in MIL STDs 785 and 470, respectively. It is apparent from this and other studies, however, that implementation of the directives and the R&M Program Plans varies among different types of equipment and different weapon system programs.

There is little doubt that systems with higher reliability are achievable, but the overriding issue is the ability to hold together all key programmatic aspects of the structure when faced with the conflicting demands of funding, schedule, system, and political constraints. While the R&M elements of the acquisition process are generally well-known, the interrelationships and dependencies of elements and subelements are not so well understood. As a consequence, we find cases where management has traded R&M elements for apparent cost reductions and/or improved schedules, but which ultimately has led to overruns, delays, and costly downstream logistics problems.

The management and engineering challenge is to structure an acceptable disciplined approach to planning programs to ensure balanced considerations of performance, budget, schedule, and supportability; and to ensure that the appropriate balance is not lost as the program progresses through its various phases.

The elements of a discipline for planning and analyzing R&M attributes of program structuring were identified during this study. The discipline encompasses considerations for variations in programs and their acquisition environment, how they are structured for R&M, the interrelationships and dependencies of program elements, concurrency and scheduling. It provides the visibility to understand reliability, maintainability, and readiness implications of program structuring (Vol. II, Section IV-A.1; Vol. III, Section IV).

Recommendation:

DoD should issue a "Guide to Structuring a Weapon System Program for R&M," developed by the Services and endorsed by the Joint Logistic Commanders, which includes:

- Emphasis on early incorporation of R&M requirements into engineering design based on specific program structure techniques such as are recommended in this study (Vol.

III, Appendix B) coupled with techniques such as the Navy is developing, and including means for validation testing during development and a formal maturation phase for production units.

- Establishment of a funding profile at the outset of the development phase that supports the development, growth, and maturing of R&M elements in the program structure through FSED and early production. Priorities should be placed on analysis to improve present planning factors and estimates for the cost of R&M activities.
- Firmly established audit procedures to ensure that DoD directives and R&M program requirements are being followed in a consistent and effective manner.

FINDING 4: RECENT DEVELOPMENTS IN PROGRAM STRUCTURING

Whereas the critical elements of a reliability by design approach have come to be known and widely accepted, two elements--computer-aided design engineering and manufacturing (CAD/CAM) and environmental stress screening (ESS)--are rapidly developing and deserve special attention.

Comment:

Rapid evolvement of computer-aided design engineering and manufacturing offer a major opportunity to analyze more completely the R&M features of the design prior to commitment to hardware. To achieve this potential requires a strong commitment to develop the needed data bases and to integrate comprehensive analysis capabilities into CAD/CAM systems. Industry progress and intentions in this area are mixed.

Environmental stress screening has gone through rapid evolution. A wide variety of approaches are being practiced which differ substantially in intensity, cost and payoff. (Vol. II, Section IV-A.2; Vol. III, Section IV).

Recommendation:

OSD and the Services should sponsor a task on computer-aided design and engineering for R&M in order to establish the criteria, a requirements approach and the funding needed to rapidly achieve the potential R&M improvements through design and design analysis.

A policy should be established that ESS must be applied to all acquisitions. DoD should fund sufficient promising ESS approaches to define a consistent set of ground rules for specifying requirements and for evaluating contractor proposals.

FINDING 5: R&M STANDARDS

Advancing technology and the current emphasis on R&M point to the need for improvements in specific R&M standards.

Comment:

A recurrent theme from the R&M study group reports is the lack of adequate standards in certain areas particularly related to electronic or electromechanical systems where there are currently rapidly changing technologies. These are also areas where there are current R&M problems in the field. In addition, deficiencies were noted in human factors R&M requirements, and in the design specifications for reliable use of composite materials. Increased emphasis should be placed on reviewing and updating R&M standards and specifications, particularly in the areas of testing procedures, packaging standards, human factors standards, power supply design, composite materials use, connector standards (including fiber optics), and software design. A further deficiency is that current program standards do not include the early field growth and maturation phase as a requirement. As a result this critical phase is often underfunded and ad hoc in nature. (Vol. II, Section IV-A.4; Vol. III, Section IV-A).

Recommendation:

It is recommended that a Tri-Service Board be convened to develop a specific implementation plan to review and update within the next 24 months standards and specifications for electronic or electromechanical systems, specifically related to:

- Testing procedures
- Packaging standards
- Power supply design
- Software design
- Connector standards (including fiber optics)

and, more generally, human factors standards and composite materials design specifications as they relate to R&M requirements. Further, responsibility should be assigned to revise the R&M program and supporting MIL-Standards to formalize the requirement for a planned maturation phase.

FINDING 6: MANAGEMENT INCENTIVES

There is a need for enhanced management awareness of R&M requirements by both industry and government managers during the acquisition process.

Comment:

In the design and development process many competing pressures have to be balanced, and R&M requirements are often relegated to a lower priority than they were given in the initial planning. High levels of contractor management participation in R&M were evident in all the cases in which R&M was deemed a success. Contract incentives have proven to be an effective way to ensure contractor management attention to R&M requirements. Additionally, contractors respond to perceived DoD priorities. An increased understanding by DoD managers and engineers of the critical elements of R&M programs, how those elements relate to one another, and what they contribute to R&M success would

facilitate communications with contractors that would lead to improved program structures. The Services should then be better equipped to monitor program efforts to meet R&M requirements during the acquisition process (Vol. II, Section IV-A; Vol. III, Section IV).

Recommendation:

It is recommended that the Military Departments be required to prepare and report to the Defense and Service Systems Acquisition Review Councils (DSARC/SSARCs) their plans for contractor incentives related to R&M requirements at each major milestone of the acquisition process. In addition, any proposed reallocation of funds initially programmed for R&M elements, particularly those designated for component and subsystem growth testing, should be reported along with projected adjustments in R&M achievements and schedules.

FINDING 7: NEW SYSTEM MATURATION

The use of new and evolving technology in system development requires a planned and funded R&M maturation phase that begins early in system development and continues until several years after a system is fielded.

Comment:

It should be recognized that when systems are first fielded they generally are not fully developed, i.e., they are still subject to failure from unforeseen conditions due to design deficiencies or unspecified operational demands. In spite of the best design and manufacturing efforts, there still remain significant unknowns that cannot be detected and addressed until a system is being operated and maintained in the field by the actual user. An exception may be spacecraft, where extensive use of redundant systems and elaborate testing is undertaken in the development/production process to ensure failure-free

operation. For most systems, however, particularly if potential failures are not seen to be life-threatening, the expense of such elaborate design and testing is not justified, provided a well-organized product improvement program is carried out (Vol. II, Section IV-A.4; Vol. III, Section IV).

Recommendation:

R&M growth and maturation programs for major equipments should be included early in program management plans and carried through to satisfy field operations. Such programs should include rapid feedback of field failure data, use of contractor personnel for investigation and establishment of product improvement changes, and rapid approval of corrective measures. Failure data should also be fed to the appropriate Service laboratories (see Recommendation 8). Where appropriate, equipment could be bailed back to the laboratories for extensive testing. The program should continue until the system has satisfied user expectations.

D. SPECIFIC AREAS OF CONCERN

FINDING 8: COLLECTION AND USE OF FIELD R&M DATA

Current methods of collection, analysis, and dissemination of field R&M data are not sufficient to identify underlying causes of failure and thus facilitate reliability, maintainability, and/or readiness improvements.

Comment:

Every working group involved in this study implicitly or explicitly identified a need for better information on the cause of failures in the field (Vol. II, Section III; Vol. IV, Section V). The normal data produced by the maintenance data collection systems usually does not provide the kind of

information needed for engineering analysis of failures. Wide variations in the results of using data from the same data base have been observed in the course of this study (Vol. III Section IV-B). The commercial sector is far ahead of the military in the collection of accurate data, as is demonstrated by the grocery-store laser beam bar-code reader. In contrast, the current military data systems rely mostly on the handwritten input of maintenance technicians, or in some cases, special data collectors. What appears to be needed is a two-fold approach which involves routinely funding contractor data collection and analysis for design feedback during early fielding, coupled with application of low-risk information technologies to improve the accuracy of data collection and to flag problems for detailed investigation by experts. The DoD laboratories should be involved in this effort. (Vol. II, Section IV-B; Vol. III, Section IV).

Recommendation:

The Military Departments should initiate programs to improve the accuracy and the coverage of current maintenance data systems by exploiting low-risk information systems technology. Lead laboratories should be designated for field data analysis in major technology areas and should be supported to initiate research studies of generic problems, in order to expand the technology base data available to designers. Contractors should be routinely funded to analyze field R&M problems on new equipment.

FINDING 9: R&M TRAINING FOR MANAGERS

There is a real need to upgrade the level and scope of R&M training throughout DoD and to relate it more closely to current manpower skill levels.

Comment:

Analysis of the case studies indicates that contractors do respond to perceived DoD priorities. One factor that contributed to contractor perception of the importance that DoD placed on R&M was the capability and knowledge of DoD personnel on R&M-related items.

Currently, R&M training is provided by a number of separate DoD Service schools, contractors and educational institutions, but it is fragmented and limited in scope. As a result, it is essential that more attention be focused on the educational process and that current DoD educational bodies take steps to coordinate and improve the content of their acquisition management, reliability, maintainability, and design courses. This training will lead program managers to understand the consequences of their respective programmatic decisions (Vol. II, Section IV-C; Vol. III, Section IV).

Recommendation:

OSD should assign executive agent responsibility for R&M training to an existing organization with instructions to work closely with all DoD training institutions in developing a comprehensive, coordinated R&M curriculum.

FINDING 10: DIAGNOSTICS

Diagnostics and in particular built-in-test could become the weak link in the support chain if substantial efforts are not mounted now to codify requirements, design, verification, and maturation processes.

Comment:

Weapon systems have become heavily dependent on built-in diagnostics to indicate subsystems and units which must be replaced. Major problems have occurred on a wide scale in

achieving accuracy and low false alarms. A substantial increase in spares costs and unnecessary repairs results.

Problems in acquiring systems with diagnostics that work span the range of precision in requirements, and environment, design practices, verification and demonstration approaches, and maturation. Solution to diagnostic system problems has been hampered by fractionation of design, test equipment, and human factors efforts. Thus the trade-offs between built-in and external diagnostics are not well established. (Vol. II, Section IV-A.5; Vol. III, Section IV).

Recommendations:

DoD should assign responsibility for development of a set of MIL-Standards for diagnostics specification, design, development, verification, and maturation under the unifying umbrella of an overall program plan. These efforts must be supported with full-time personnel and adequate resources.

The Services should fund efforts to collect and analyze field data on military and civilian systems with extensive built-in diagnostics to quantify relationships between diagnostic performance (detection, isolation, false indications, errors) and support system effectiveness.

A P P E N D I X A

TASK ORDER

68/18-1

OFFICE OF THE UNDER SECRETARY OF DEFENSE

WASHINGTON D C 20301

ESEARCH AND
ENGINEERING

2 April 1982

TASK ORDER
NO. MDA903 79 C 0018: T-2-126

TITLE: Steps Toward Improving the Materiel Readiness Posture of the DoD (Short Title: R&M Study)

1. This task order is for work to be performed by the Institute for Defense Analyses (IDA) under Contract MDA903 79 C 0018 for Manpower, Reserve Affairs and Logistics.

2. PURPOSE:

To identify and provide support for high-payoff actions which the DoD can take to improve the military system design, development and support process so as to provide quantum improvements in R&M and readiness through innovative uses of advancing technology and program structure. The DoD objective is to enhance the peacetime availability of major weapons systems and to enhance the ability to make a rapid transition to high wartime activity rates, to sustain such rates and to do so with the most economical use of scarce resources possible.

3. SCOPE:

To (1) identify high pay-off areas where the DoD could improve current system design, development program structure and system support policies, with the objective of enhancing peacetime availability of major weapons systems and the potential to make a rapid transition to high wartime activity rates, to sustain such rates and to do so with the most economical use of scarce resources possible, (2) assess the impact of advancing technology on the recommended approaches and guidelines, and (3) evaluate the potential and recommend strategies that might result in quantum increases in R&M or readiness through innovative uses of advancing technology.

The basic questions to be addressed in the study are:

(1) What are reasonable expectations for raising system reliability and maintainability goals, making the best possible use of improved reliability management techniques which have been demonstrated and of emerging maintenance technologies--diagnostics, computer-aided maintenance training, etc.?

(2) What are the estimated utility and costs (in needed additional resource expenditures) of attaining these goals?

(3) To the degree such attainment is worthwhile, how can it best be implemented?

It is desired that the focus of the study be a pragmatic, in-depth review of several of the more successful recent major systems and sub-systems developments, of developing technologies with particular potential for improving maintenance effectiveness and of such recent studies which can contribute to the integration and interpretation of the data obtained. The emphasis should be placed upon the elucidation and integration of the expert knowledge and experience of the engineers, developers, managers, testers and users involved with the complete acquisition cycle of the selected systems as well as upon supporting analysis. The results are intended for possible application, as appropriate, to new weapons systems and sub-systems now in the planning or development stage.

4. <u>SPECIFIC TASKS AND ADDITIONAL GUIDANCE</u>:

a. A review will be made of recently acquired systems and/or sub-systems with perceived above norm R&M, and developed using practices representative of each Service, in order to determine:

(1) What were the R&M objectives and how were they arrived at?

(2) How were the programs structured to meet the objectives?

(3) How did costs, schedule and performance objectives impact the R&M levels that were achieved?

(4) The acquisition, contractual, incentives and funding approaches used.

(5) What engineering approaches were taken and how was technology applied to meet these objectives?

(6) How were the evolving systems tested and what approach was used to correct deficiencies?

(7) What were the effects of reducing the support tail or otherwise simplifying the support structure?

b. Assess diagnostics technologies; specifically, include BIT and ATE approaches used in systems with above norm performance. Also, compare the original estimates of numbers and skills levels of the maintainers required with the actual numbers and skills levels required for these or other systems.

c. Assess the potential impact of new and advancing technology on the recommended approaches for R&M and diagnostics. Recommend how best to exploit this new technology in order to achieve R&M, diagnostic, or readiness improvements. Include the recommendation of innovative support or design concepts that would have significant beneficial impact from the new technology.

d. Analyze and assess the pros and cons of the approaches (particularly contracting approaches, funding, testing, R&M engineering practices) used and develop specific combinations of these approaches or modifications of them that can be applied to various weapon types.

e. Integrate the results into a form appropriate for presentation to a high level joint Industry/Service group whose objective will be to review and develop further recommendations that would lead to the development of weapon systems with improved R&M. The application will be to new weapons systems now in the planning or development stage.

It is expected that a phased approach will be used. The phasing is to permit flexibility in staffing as the nature of the effort changes, to permit meaningful periodic review of progress and results and to permit redirection in approach in response to interim lessons learned. It is further anticipated that extensive use will be made of the workshop approach to ensure combined depth and breadth of review as well as to permit meaningful involvement by the ultimate implementers of study results.

Phase 1--*Organization and Planning.*

This effort is to develop the basic study rationale, organization and plan of action for review and approval to proceed by the cognizant office and IDA. Available data and information will be gathered and utilized to the degree feasible in achieving the following basic Phase 1 objectives:

(1) Compile and assess R&M figures-of-merit to represent system readiness, reliability, maintainability and support manpower needs, both in peacetime and wartime.

(2) Develop and apply the rationale for selection of systems and/or sub-systems to be studied.

(3) Develop the plan for the organization, staffing and implementation of the study. Specific attention should be paid to the need for tapping the diverse sources of in-depth knowledge which exist among contractors, and Service laboratory, development, test and operational units.

(4) Develop an initial approach to the integration and analysis of the information developed and its application to the development of improved approaches to better reliability and maintenance.

Phase 2--Program Reviews.

For each selected weapons system and/or sub-system program and for technologies selected, carry out the planned study activities to address the issues identified in 5(a),(b). Complete the acquisition of such other data or studies needed for Phase 3. A preliminary report of findings shall be made in October 1982.

Phase 3--Analysis and Integration.

Carry out specific tasks 5(c),(d), analyze the pros and cons of the alternative approaches devised, perform informal structured reviews and critiques with the community of potential implementers of study results. Prepare draft reports suitable for Phase 4.

Phase 4--DoD Review.

IDA is requested to support this effort by:

(1) developing, organizing and presenting the study results, suggestions for high-payoff actions and technical issues to be addressed;

(2) provide technical support to Review Group activities;

(3) summarize the proceedings of the meeting and prepare draft formal recommendations for Review Group review and approval.

Phase 5--Follow-on Study.

As agreed by the cognizant office and IDA, and within funding limitations then existing, carry out recommendations of the DoD Review Group for additional special study activities.

5. *SCHEDULE:*

This is planned to be a multi-year study. During FY 1982, Phase 1 is to be completed and Phase 2 undertaken. The Phase 1 results are to be completed and briefed to the cognizant office within 90 days of initial staffing of this effort. Interim Phase 2 results, consisting of initial review and analysis of selected programs and a preliminary technology assessment, shall be completed and briefed to the cognizant office by October 15, 1982 and a draft report submitted 30 days thereafter. Remaining schedule milestones will be as approved jointly by the cognizant office and IDA following review of Phase 1 results.

6. COORDINATION:

Throughout the study effort, coordination will be maintained, through the cognizant office, with the offices of Acquisition Management, Assessment, and Tactical Warfare Programs. The cognizant office will provide guidance to the study group as to the nature and form of results judged to have maximum potential value.

7. FUNDING:

$400,000 is authorized to be expended in FY 1982. $400,000 is planned for FY 1983. Complete resource planning is contingent upon review and approval of Phase 1 results.

8. TECHNICAL COGNIZANCE:

The cognizant office for this study is Special Assistant for Weapon Support Improvement (MRA&L).

9. SPECIFIC ADMINISTRATIVE INSTRUCTIONS:

a. If at any time during the course of this task, IDA identifies the need for changes in this task, such as additional resources, schedule modification, changes to emphasis of effort or scope, etc., as set forth in the above paragraphs, a report, with appropriate recommendations, will be submitted in accordance with the terms of the IDA/WSEG Memorandum of Understanding of 12 March 1975 (and its successor) as applicable to the Executive Secretary, DOD-IDA Management Office, OUSDRE, with a copy to the sponsor or his project officer, as appropriate. Changes in this task will be made only with the approval of appropriate cognizant DoD officials.

b. This task will be conducted under Industrial Security Procedures in the IDA area. If certain portions of the task require the use of sensitive information which must be controlled under military security, the DOD-IDA Management Office will provide supervised working areas in which work will be performed under military security control.

c. A "need to know" is hereby established in connection with this task and access to classified documents and publications and security clearances necessary to complete the task will be obtained through the DOD-IDA Management Office unless otherwise instructed. Report distribution and control will be determined by the sponsor.

James B Statler

JAMES B. STATLER
Colonel USA
Director
DOD-IDA Management Office

FOR IDA: Alexander H Flax
ALEXANDER H. FLAX
President, Institute for Defense Analyses

DATE: April 8, 1982